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CHALCOALUMITE, A NEW MINERAL FROM BISBEE, ARIZONA.

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INTRODUCTION

Among a number of specimens from Bisbee, Arizona, sent to the authors for identification by Mr. English of Ward's Natural Science Establishment, three contained a crust of a delicate blue-green material that proved to be homogeneous on microscopic examination and had optical properties that did not agree with those of any known mineral. Mr. English and Ward's Natural Science Establishment generously presented us with the specimen that seemed most suitable for further study, and we acknowledge our indebtedness to them.

A chemical analysis and further study showed that the mineral is a new hydrous aluminum copper sulphate and we propose the name *chalcoalumite* for it.

We have since identified the mineral in two other specimens from Ward's collections; and Professor Palache has identified it on two specimens in the collection of Mr. Vaux of Philadelphia. Several specimens in the collection at Harvard University, called to our attention by Professor Palache, are with little doubt an alteration product of chalcoalumite. No doubt the mineral will be found in other collections. The specimens we have identified have been labelled either chrysocolla or allophane.

OCCURRENCE

Chalcoalumite forms crusts from one to ten millimeters thick on a brown limonite-like material. More or less malachite and azurite were deposited on the limonite before the chalcoalumite. Some of the specimens are clearly stalactites of limonite completely covered with a layer of chalcoalumite. From the number of specimens that have been found, the abundance of the mineral on the specimens, and the fact that it seems to have completely coated the limonite surfaces in the cavities, it is probable the chalcoalumite occurred in considerable quantity.

PHYSICAL PROPERTIES

Chalcoalumite forms botryoidal crusts which are made up of fibers approximately normal to the surface to which they are attached. The color is turquois green (Ridgway 41. d),[1] or nile blue (Ridgway 41′. d).[1] The main crust is dull, rather porous, and made up of very minute, matted fibers, while a thin outer layer is dense, vitreous, somewhat darker colored and more coarsely crystalline. None of the crystals are large enough for measurement on the goniometer. On one of the specimens the mineral is more coarsely crystalline and good interference figures were obtained.

Chalcoalumite has a specific gravity of 2.29[2] measured with a pycnometer. It has a hardness of 2 ½ and fusibility of 5.

The mineral is optically +, the axial angle is rather small, and the dispersion of the axial angle is strong, $\rho > \nu$. The indices of refraction are: $\alpha = 1.523$, $\beta = 1.525$, $\gamma = 1.532$.

The material is not satisfactory for accurate determination of the optical orientation or for good crystal data. The best crystals or cleavages are lath shaped in outline with the terminal edge making an angle of about 60° with the length. Some are equilateral triangles. The acute bisectrix, Z, makes a large angle with the normal to the laths. Crystals lying on this flat face do not give sharp extinction in white light due to the strong dispersion. They have negative elongation and one extinction position makes an angle of about 32° with the long edge and lies in the acute angle between the long edge and the terminal edge. Some of the laths are twinned with the twinning and composition plane parallel to the long edge and nearly normal to the flat face. Such laths have reentrant angles, and symmetrical faces and extinction.

Turned on edge the laths have an extinction angle of about 40° and negative elongation. An interference figure on this face shows the emergence of the acute bisectrix, *Z*, just out of the field of the microscope and the plane of the optic axis across the length.

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[1] Ridgway, Robert. Color Standards and Nomenclature. Washington, D. C., 1912.

[2] The specific gravity, calculated by the law of Gladstone and Dale using the mean index of refraction and the values of k given by Larsen, is 2.25, a very close check. See Larsen, E. S. Microscopic Determination of the non-opaque minerals, *U. S. Geological Survey, Bull.* **679**, pp. 30-31, (1921).

The matted fibers are so minute and intergrown that they give aggregate effects and appear to have parallel extinction, +elongation, and abnormal blue interference colors. The coarser fibers give sharp parallel extinction for some orientations and large extinction angles and strong dispersion for others.

The data are not entirely satisfactory, but the mineral is probably triclinic. There are believed to be several perfect cleavages but it was not possible to distinguish between cleavages and crystal faces.

CHEMICAL PROPERTIES

Chalcoalumite is not readily soluble in cold dilute acid but it is readily soluble in hot concentrated acid. Two chemical analyses, by Miss Vassar, on samples fom two separate specimens are given below together with the ratios and the theoretical composition corresponding to the formula. The material selected for analyses was carefully hand-picked and, examined under the microscope, was found to contain only traces of impurities. It was made up of both the fine porous inner layer of submicroscopic fibers and the denser, more coarsely crystalline outer layer. The first analysis was from the specimen that had the thickest crust—about five millimeters thick—and the second from a large specimen with a much thinner crust.

ANALYSES AND THEORETICAL COMPOSITION OF CHALCOALUMITE.

	Specimen 1	Specimen 2	Theoretical
Insol.	0.09	0.28	
Al_2O_3	38.71	38.88	38.81
MgO	0.05	(1.01)*	
CaO	0.01		
Na_2O	0.50		
K_2O			
H_2O-	28.95	30.60	30.82
H_2O+	1.90		
SO_3	14.80	14.67	15.22
CuO	14.78	14.56	15.15
	99.79	100.00	100.00

* Impurities by difference.

Water was determined by the absorption tube method with previously ignited CaO in the combustion tube to retain any SO_3.

Copper was determined gravimetrically, first precipitating the copper as CuS and then roasting it over to CuO. That method was checked on a separate sample by the volumetric KI method.

The analyses made on the mineral from the different specimens show a very close similarity. They agree very closely with the theoretical composition, $CuO.2Al_2O_3.SO_3.9H_2O$, although the SO_3 and CuO are a trifle low. If the alkali is added to the CuO the agreement for the CuO is very close. The formula may be interpreted as $CuSO_4.4Al(OH)_3+3H_2O$.

ALTERATION

Several specimens in the collections of Harvard University called to our attention by Professor Palache, are much paler colored than the chalcoalumite but are otherwise very similar, both in their mode of occurrence and structure. Microscopic examination showed that they are not all alike. They are almost certainly pseudomorphs after chalcoalumite. The crust on one sample is made up of minute fibers and plates that are biaxial +, have a small axial angle, *Z* normal to the fibers, and *X* parallel to the elongation. They tend to be on a perfect cleavage normal to *Z*. α and $\beta = 1.571$. Birefringence about 0.02. A partial analysis gave

SiO_2	2.5
Al_2O_3	57.8
H_2O	35.0
CuO	2.6
Insol.	0.7
	98.6

The composition and optical properties agree with those of gibbsite and the material is no doubt an impure gibbsite.

The crust on another specimen is very finely crystalline, has a mean index of refraction of 1.558, and a birefringence of about 0.02. A partial analysis showed

SiO_2	20.12
Al_2O_3	50.67
Fe_2O_3	.26
H_2O	27.11
CuO	1.41
	99.57

This agrees rather closely with the formula $3Al_2O_3.2SiO_2.9H_2O$, but the sample is so fine grained that its homogeneity cannot be vouched for and it may be a mixture of silica and gibbsite.

SUMMARY

Chalcoalumite from Bisbee, Arizona, occurs as turquois green crusts up to several millimeters thick completely coating stalactites and related deposits of limonite and copper carbonates. It has a hardness of about 2 ½, a specific gravity of 2.29, and a fusibility of 5. It is made up of matted fibers. It is probably triclinic, has several perfect cleavages, and the more coarsely crystalline outer crust if powdered is partly in laths that have terminal faces making angles of about 60° with the length. Twins with the twinning plane parallel to the long edge of the laths and nearly normal to the laths are rather common. The mineral is optically +, $2V$ is rather small, $\rho > \nu$ is strong, $\alpha = 1.523$, $\beta = 1.525$, $\gamma = 1.532$. The laths give no sharp extinction in white light but they have negative elongation and extinguish at about 40° to the length. Turned on the long edge they show negative elongation and strong dispersion with extinction at an angle of about 32° to the length. The mineral has the composition $CuO.2Al_2O_3.SO_3.9H_2O$ or $CuSO_4.4Al(OH)_3.3H_2O$.

XONOTLITE AND PECTOLITE IN A DIABASE PEGMATITE FROM MINNESOTA*

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INTRODUCTION

A discovery of considerable amounts of xonotlite in the Pigeon Point region of Cook County, Minnesota, was described in a recent number of The American Mineralogist.[1] An additional occurrence was found during the summer of 1924 over a hundred miles from the first. Pectolite, an associated mineral, is new to the state of Minnesota. This deposit has certain similarities and also certain distinct differences from the other, and is instructive as to the origin and associations of the mineral.[2]

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* Published by permission of the Director of the Minnesota Geological Survey.

[1] Schwartz, G. M., An occurrence of xonotlite in Minnesota: *Am. Min.*, **9**, 32-33 (1924).

FIELD RELATIONS

The material was found in a vein dipping a few degrees west in a big bluff of intrusive diabase on the coast of Lake Superior about five miles east of Two Harbors.[3] This bluff formerly stood as a bold cliff over 200 feet high, but the face has been blasted down to form a road bed for the new lake shore highway. The vein was exposed by the blasting and the material was apparently only slightly weathered as it was covered by scores of feet of diabase.

The diabase is a coarse black rock and is one of the many Keweenawan basic intrusives included in the Beaver Bay diabase series of the Minnesota coast. The sill transgresses across the rhyolite flows which are just above water level at the southwest end of the exposure and rise to a height of 125 feet above the lake to the northeast, although the normal dip of the flows is about 12 degrees to the southeast. However, the areal extent of the intrusive is great and it may be conveniently referred to as a sill. The vein in which the xonotlite was found may be traced along the face for 200 feet or more.

XONOTLITE AND ASSOCIATED MINERALS

The xonotlite formed the core of two specimens, one about 2×3×4 inches, and the other $2\frac{1}{2}$×3×6 inches. These were obviously broken and doubtless much more of the material has been covered up by the blasting. The outside of the specimens consists of large black augite grains enclosing lath-like forms of greenish material, thus giving a very coarse diabasic texture to the outer part of the fragments. The core consists mainly of a dense, light pinkish mass of xonotlite, penetrated around the outside by augite crystals and more or less intergrown with the various minerals of the border. The xonotlite exhibits the usual hard and tough properties which, with the pinkish color and dense nature, serve to identify it in hand specimen. This material apparently retains its pink color on exposure whereas the mineral from Cook County quickly fades to a dull gray on exposure. An analysis is given in the following table.

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[2] After this paper was submitted for publication the writer, through the courtesy of Dr. Walter F. Hunt, was permitted to see the paper by E. V. Shannon which appeared in the January issue of this magazine. The association of the mineral with diabase is apparently a common one. The associated minerals in the Virginia occurrence are of the same general type as those of the Minnesota occurrences. Possibly the pale bluish-green fibrous silicate noted by Shannon is prehnite.

[3] On shore near center line of Sec. 22, T. 53 N., R. 10 W.

Analyses of Minerals

	1	2	3	4
SiO_2	48.60	42.00	42.80	48.90
Al_2O_3	0.67	22.39	19.92	9.54
FeO	1.35	3.01	2.82	0.96
MgO	0.20	0.07	0.72	0.11
CaO	46.12	27.56	28.76	31.44
Na_2O	n.d.	n.d.	n.d.	4.62
K_2O	n.d.	n.d.	n.d.	0.38
H_2O	3.10	4.70	5.02	4.28
	100.04	99.73	100.04	100.23
Sp. G.	2.655	2.827	2.845	

1. Xonotlite from vein in diabase bluff on Lake Superior, Sec. 22, T. 53 N., R. 10 W. J. W. McCarthy, analyst.
2. Prehnite from Sec. 35, T. 64 N., R. 5 E., Cook County, Minn. (Called diopside, *Am. Min.*, **9**, 32.) J. W. McCarthy, analyst.
3. Prehnite, same specimen as No. 1. J. W. McCarthy, analyst.
4. Fibrous aggregate of prehnite and pectolite. Analysts, J. W. McCarthy and R. J. Leonard.

Thin sections show that the xonotlite is made up of a very fine interlocking mat of fibers, much like the mineral from Cook County, but the fibers are distinctly smaller. Scattered through the xonotlite are occasional spherulitic aggregates of prehnite and remarkable radiating aggregates of fibrous pectolite.

Much of the material intergrown with augite has a light green color and a sheaf-like structure. It appears to correspond with the material described as diopside which formed the border of xonotlite nodules from Cook County.[4] However, the indices were found to be below those of diopside and a detailed examination and analysis proved the mineral from both locations to be prehnite. The analyses are given in the table and correspond closely with the analyses of the mineral cited by Dana.[5] Associated with the prehnite in the Two Harbors material are perfect radiating aggregates of pectolite. (See Fig. 1). Scattered throughout the areas of prehnite and pectolite is a dusty material with a slightly greenish luster in reflected light. This is apparently kaolinite and it may be seen to outline the former plagioclase laths at places. The lath-like forms of the former plagioclase grains are easily seen in hand specimens and in plain light microscopically, but largely disappear in polarized light, due to the complex and messy nature of the alteration products. Associated with the augite of the border material are small amounts of magnetite surrounded by dusty areas of leucoxene, thus suggesting an original content of ilmenite. Small amounts of chlorite are also scattered through the slides and an occasional grain of apatite remains embedded in the secondary material.

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[4] *Am. Min.*, **9**, 32-33 (1924).

[5] System of Mineralogy, p. 531.

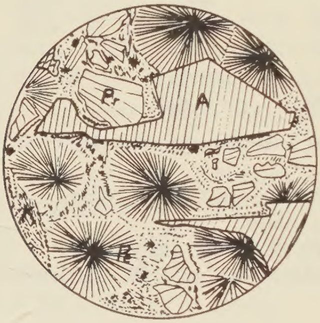

Fig. 1

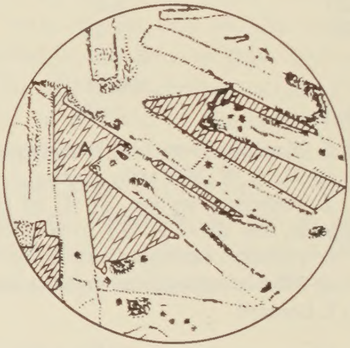

Fig. 2

Figure 1. Sketch of a thin section from the diabasic pegmatite border surrounding the xonotlite masses. Augite (A) remains perfectly fresh whereas plagioclase and probably other primary minerals have altered to pectolite (Pe), prehnite (Pr), and kaolinite (K). Polarized Light, Mag. X 8.

Figure 2. Sketch of a thin section from same material as Figure 1. Note the sharp boundaries of augite (A) penetrated by laths which are in part outlined by dusty kaolinite. The laths consist of pectolite, prehnite, kaolinite and chlorite. Plain Light, Mag. X 8.

It seems obvious from the texture of the material surrounding the xonotlite that plagioclase once formed an important part of the material, but only one slide showed remnants of the feldspar. In the others the plagioclase, which was probably of a calcic variety, has completely altered to a mixture of prehnite, pectolite and kaolinite. (See Fig. 2). The almost perfectly fresh nature of the augite is noteworthy in view of the nearly complete disappearance of the feldspar.

Associated with the specimens containing xonotlite are smaller masses consisting mainly of white radiating fibrous aggregates of pectolite, wih lesser amounts of green to colorless spherulitic aggregates of prehnite. The two minerals are so intimately mixed that they could not be separated, but an analysis of the material (see table of analyses), indicates that the minerals were correctly determined. The structure of the pectolite distinguishes it from prehnite. There is no indication that these masses are pseudomorphous as is the material described above.

Discussion

The texture of the original diabasic material of the vein is much coarser than that of the diabase sill, thus indicating that the vein is in the nature of a diabase pegmatite subsequently altered by hot solutions.

The general mode of occurrence of the xonotlite as the center of somewhat nodular masses surrounded by diabase pegmatite material suggests that the xonotlite was formed about the time of the formation of the pegmatite. However, its hydrous nature suggests that it originated from the hot solutions which followed the vein and resulted in the alteration of plagioclase to a complex mixture of prehnite, pectolite, and kaolinite. It is remarkable that the augite almost completely escaped alteration.

Some of the smaller masses of pectolite and prehnite described above show no remnants of earlier minerals or textures and it seems probable that the material was deposited from solution, rather than formed by alteration of the feldspar.

The xonotlite from Cook County and the occurrence described here show the similarity of a border of prehnite surrounding the xonotlite; both deposits were apparently formed under high temperature conditions as indicated by the sulphides[6] of the Cook County deposit and the pegmatitic nature of the Two Harbors occurrence. Furthermore, both occurrences are in Keweenawan diabase intrusives. The Two Harbors occurrence shows no sulphides but does contain considerable amounts of pectolite which is not found in the Cook County deposit.

So far as known, this is the first occurrence of pectolite reported from Minnesota, though Winchell[7] noted that it had been found on

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[6] See Schwartz, G. M., *Am. Min.*, **9**, 32-33 (1924), and a fuller description to appear in *Econ. Geol.* in **1925**.

[7] Winchell, N. H., *11th Ann. Rept. Geol. and Nat. Hist. Survey Minnesota* p. 22, **1883**.

Isle Royale. Prehnite has been reported from several places along the north shore of Lake Superior in Minnesota, and Grout[8] has given an analysis of the mineral from Pine County.

The writer is indebted to the Minnesota School of Mines Experiment Station for analyses, and to Dr. F. F. Grout for much assistance.

[8] Grout, F. F., Contributions to the petrography of the Keweenawan: *Jour. Geol.*, **18,** 654 (1910).

A NEW THEORY OF THE COMPOSITION OF THE ZEOLITES*

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INTRODUCTION

The great similarities in composition between the zeolites and the feldspars have been pointed out many times, but in a summary of previous studies Dana[1] expressed correctly the conclusion reached by all investigators of the subject, as follows: "Unlike the feldspars (in zeolites) . . . calcium and sodium seem to replace one another and an increase in alkali does not go with an increase in silica." The formulas given by Dana and all other authorities known to the writer show that in zeolites alkalies are supposed to replace lime under the control of valence, that is, two atoms of Na or of K are supposed to take the place of one atom of Ca.

It may be worth while to be more specific in regard to the present situation as to the composition of the zeolites. Dana gives the following formulas as representing the composition of the zeolites named:

Thomsonite	$(Na_2, Ca) Al_2Si_2O_8 . 2.5 H_2O$
Chabazite	$(Ca, Na_2) Al_2Si_4O_{12} . 6 H_2O$
Gmelinite	$(Na_2, Ca) Al_2Si_4O_{12} . 6 H_2O$
Wellsite	$(Ba, Ca, K_2) Al_2Si_3O_{10} . 3 H_2O$
Phillipsite	$(K_2, Ca) Al_2Si_4O_{12} . 4.5 H_2O$
Harmotome	$(K_2, Ba) Al_2Si_5O_{14} . 5 H_2O$
Stilbite	$(Na_2, Ca) Al_2Si_6O_{16} . 6 H_2O$
Mordenite	$3(Ca, Na_2, K_2) Al_2Si_{10}O_{24} . 20 H_2O$
Ptilolite	$(Ca, K_2, Na_2) Al_2Si_{10}O_{24} . 5 H_2O$

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* Presented at the annual meeting of The Mineralogical Society of America, Ithaca, New York, December 31, 1924.

[1] System of Mineralogy, 6th Ed., p. 570, (**1892**).

According to Dana the other common zeolites have invariant composition. The same or very similar formulas are given by Groth, and all other authorities, so far as known to the writer. That is, according to standard authorities, any zeolite which is not invariant is supposed to show a variation in the Ca : Na (or K) ratio, and no other corresponding variation.[2] Furthermore, in this variation two atoms of Na or K are supposed to replace one atom of Ca.

Zeolites are commonly regarded as more or less exactly hydrous equivalents of feldspars. In plagioclase and other feldspars it is well known that one atom of Ca is replaced, not by two atoms of Na (or K), but by one atom of alkali with a simultaneous replacement of one atom of Al by one atom of Si. Therefore it may be worth while to study the best analyses of the various zeolites to learn whether they resemble the feldspars in this respect, rather than showing variations in composition as represented by the formulas universally used for them. Such a study is a long and difficult matter except by means of graphs. By plotting the best analyses of each kind of zeolite on a square[3] so arranged that the horizontal coordinate expresses variation in the Ca : Na ratio and the vertical coordinate expresses variation in the Al : Si ratio, the distribution of the points, each of which represents an analysis, shows at a glance whether the composition varies as in the feldspars, or as in the formulas now accepted. It is evident that the points representing the variations in composition in one kind of zeolite must lie along a horizontal line in such a diagram if the usual formulas are correct. Also, if the variation in the Ca : Na ratio is accompanied by a simultaneous variation in the Al : Si ratio the points representing the variations in composition in one kind of zeolite must lie along a line taking a diagonal course on the square.

Such diagrams are not difficult to prepare nor entirely novel, but, since they do not seem to be familiar to mineralogists, it seems necessary to explain the method of preparation.

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[2] Groth (Mineral. Tabellen, **1921**) and Tschermak (*Sitz. Akad. Wiss. Wien*, **CXXVI** (1917), p. 541 and **CXXVII**, (1918), p. 177) recognize variations in the Al:Si ratio in some zeolites, but fail to show any relation between such variations and those in the Ca:Na ratio. Gordon (*Proc. Phila. Acad. Sci.*, **LXXVI**, (1924), p. 103) has found the approximate relationship in these ratios in thomsonite, but did not discover the atom-for-atom type of replacement, recognizing instead a replacement of Ca by 2Na, and of 2Si by 3Si

[3] Full details regarding the preparation of the graphs are given later.

Starting with any molecule, for example $Ca_3Al_6Si_{10}O_{32}$.Aq. at one corner of a square, as at A in the figure, let us assume that this molecule may change gradually to the corresponding sodium salt, $Na_6Al_6Si_{10}O_{32}$.Aq. and let us represent this entire change by a horizontal line as AB. By dividing this line into ten equal parts, each division point represents these two molecules mixed in simple decimal ratios.

Starting again with the molecule $Ca_3Al_6Si_{10}O_{32}$.Aq. at A let us assume another kind of variation, in this case variation in the Al : Si ratio. In the first molecule assumed this ratio is 6 : 10. Let us assume in a second molecule that it changes to 10:6. If there were no other change this would lead to the molecule $Ca_3Al_{10}Si_6O_{30}$.Aq. However, all authorities are agreed that in zeolites the $Ca+Na_2:Al_2$ ratio is always 1:1. Therefore the molecule should be written: $Ca_5Al_{10}Si_6O_{32}$.Aq. This molecule may be placed at C, and the line AC made equal to AB, and divided in the same way, so that the divisions represent simple decimal mixtures of the two molecules A and C.

Now the molecule $Ca_5Al_{10}Si_6O_{32}$.Aq. at C may obviously be assumed to vary to a corresponding sodium molecule just as was assumed for the molecule at A. This variation is properly represented along the line CD, which is divided in ten parts like the other lines. Also, the molecule $Na_6Al_6Si_{10}O_{32}$.Aq. may be assumed to vary in its Al:Si ratio without variation in its Na:Al ratio, just as the molecule at A was assumed to do, and this variation may be represented along the line BD.

Since the zeolites do not form a single isomorphous system like the feldspars, but include several disconnected series, it is necessary to discuss them separately; for convenience they will be treated in the following order:

1. The composition of thomsonite.
2. The composition of natrolite, mesolite, scolecite, gismondite and laumontite.
3. The composition of chabazite and related zeolites.
4. The composition of phillipsite and related zeolites.
5. The composition of heulandite and related zeolites.
6. Comparative study and summary.

1. THE COMPOSITION OF THOMSONITE

The theory that variation in composition of crystals is accomplished by change of one atom for another of similar size has been very useful in attacking the difficult problems involved in reaching a rational explanation of the constitution of the pyroxene, amphibole, mica and other important groups of silicate minerals.

The zeolites form a complex group of hydrous aluminum silicates which are truly extraordinary in many ways. For example, the water in them is unlike the water in most other minerals since it can be expelled without destroying (or materially changing) the crystal which contained it; the water goes off through a considerable temperature range rather than at any fixed temperature; any other fluid will enter the crystal in large amounts in the absence of water, but does not remain if water becomes available to the crystal. Furthermore, in many zeolites, a base, such as sodium, can be artificially replaced by another base, such as potassium or calcium.

Since the zeolites are so exceptional, it is quite possible that a theory which applies to other silicates will not apply to them. For example, the theory of similar-sized atom-for-atom control of isomorphous systems may not hold in the zeolite group. In fact, many analyses made by Lemberg,[4] Thugutt,[5] Gans,[6] Zoch[7] and others indicate that in the artificial exchange of bases in zeolites valence controls the process, so that, for example, Ca is replaced, not by Na, but by 2Na. It remains to be determined whether a similar valence-control exists in the natural formation of zeolite crystals.

Wherry[8] has recently discussed the composition of thomsonite with special reference to this problem, and reached the conclusion that "thomsonite" is not one mineral, but two, each a double salt of fixed formula. That is, according to Wherry, thomsonite does not illustrate the usual condition of isomorphous relationships shown in so many silicates, but should be assigned to one or the other of two definite formulas. This attitude reminds the writer of the attempt of Fouqué to refer the plagioclase feldspars to a few definite formulas rather than to a continuous isomorphous series. The view of Wherry is all the more remarkable since he himself states[9] that "the lime varies inversely as the soda" in thomsonite and his diagram shows clearly a continuous gradation from one of his types to the other.

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[4] *Zeit. Dtsch. Geol. Gesell.*, **XXVII,** (1887) p. 973; **XXXIX,** (1888) p. 561; **XL,** (1888) p. 651.

[5] *N. Jahrb. Min. B. B.*, **IX,** (1894) p. 555.

[6] *Jahrb. preuss. geol. Landesan.*, **XXVII**, (1906) p. 63.

[7] *Chemie der Erde*, **I,** (1915) p. 219.

[8] *Am. Mineral.*, **8,** (1923) p. 121.

[9] *Loc. cit.*, p. 122, footnote.

Still more recently Gordon[10] has discussed the composition of thomsonite and reached the conclusion that there is a continuous variation in composition from $CaO.Al_2O_3.2SiO_2.3H_2O$ to mix crystals containing up to 40 percent of $Na_2O.Al_2O_3.3SiO_2.H_2O$. Gordon argues that Wherry must be wrong in adopting the notion of fixed composition since Lemberg has shown that the composition of thomsonite can be changed artificially. The writer would call attention to the fact that Lemberg's analyses show that Ca is replaced by 2Na without a simultaneous increase in SiO_2, and therefore the artificial change is not a confirmation of Gordon's theory.

The evidence presented by Gordon seems very convincing, but the writer is unwilling to accept it as conclusive because it involves the necessity of believing that in the crystal space-lattice which may be assumed to be built first of $CaO.Al_2O_3.2SiO_2.3H_2O$, half the Ca atoms may be replaced by twice as many Na atoms and simultaneously half the Si atoms may be replaced by other Si atoms 50 percent more in number, that is, Ca may be replaced by 2Na and simultaneously 2Si may be replaced by 3Si. In anhydrous silicates no isomorphous series of such a kind is known to the writer. Therefore it seems desirable to study the problem further.

Doelter[11] has listed 67 analyses of thomsonite, but some of these are clearly inaccurate, and a few are averages or duplicates. It is obviously of great importance to use only the very best analyses made on carefully selected material as a basis for comparative studies aimed at the determination of the constituent molecules. Therefore only the modern analyses, made since 1880, will be used. Next, analyses of later date which are clearly abnormal or inaccurate or on impure material must be excluded, as illustrated by some which include more than trifling amounts of CO_2, or MgO, or Fe_2O_3, or have unsatisfactory totals. After these omissions, the list of preferred analyses includes the following: Doelter's Nos. 6, 9, 11, 18, 22, 23, 27, 28, 36-44, 48, 50-54, 56, 57, 61, 66, 67.

Furthermore, the following analyses belong in the same group:

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[10] *Proc. Phila. Acad. Sci.*, **LXXVI,** (1924) p. 103.

[11] Hdb. Mineral Chem. **II,** 3, (1921) p. 16.

68. Thomsonite, Quirang, Scotland, F. Heddle: *Mineral. Mag.*, **V,** (1882) p. 119.

69. Thomsonite, Borschom, Transcaucasia. K. D. Glinka: *Tr. Soc. Nat. St Petersburg,* **XXIV,** (1906) p. 1; *Zeit. Kryst.*, **XLVI,** (1909) p. 287.

70. Thomsonite, Amethyst Cove, Nova Scotia. T. L. Walker. *U. Toronto Studies, Geol. Ser.* **14,** (1922) p. 72.

71. Thomsonite, Port George, Nova Scotia. T. L. Walker. *loc. cit.*

72. Thomsonite, Franklin, N. J. S. G. Gordon: *Proc. Acad. Nat. Sci. Phila.*, **LXXV,** (1923) p. 273, and *Am. Mineral.*, **8,** (1923) p. 125.

73. "Harringtonite," Antrim, Ireland. A. and R. Brauns: *Cent. Min.*, **(1924)** p. 545. Analysis I.

74. "Harringtonite," Antrim, Ireland, A. and R. Brauns: *Cent., Min.*, **(1924)** p. 545. Analysis II.

In thomsonite, as in other zeolites, the molecular ratio of Al_2O_3 to $CaO+Na_2O$ is very nearly unity in most cases; the largest variations from this ratio in the preceding list of analyses are found in the analyses of Chauvenet (No. 41-ratio = .91), Heddle (68-.91), Todd (70-.93), Heddle (11-.94), Chauvenet (42-.94), Todd (71-.94), Manasse (22-1.06), Heddle (57-1.07), Görgey (43-1.10), Manasse (23-1.12), Luedecke (6-1.14), Prior (54-1.15) Lacroix (48-1.16), and Whitfield (72-1.16). If some variation in this ratio actually exists the writer has found no explanation for it; the evidence at present is not conclusive, but it seems reasonable to assume that the ratio is constant and unity. Since this assumption underlies all the subsequent discussion it may be worth while to add that all writers on the subject of the constitution of the zeolites make this assumption, so far as known to the writer.

Contrary to the view of Wherry, the writer finds that the analyses show a considerable range in the $Al_2O_3:SiO_2$ ratio, as well as in the $Na_2O:CaO$ ratio. The former varies from about 1:2 to about 1:2.5, and the latter varies from about 1:2 to about 1:4 (Whitfield's ratio is 1:5).

If sodium be omitted for the moment the constant unit Al_2O_3: $CaO+Na_2O$ ratio and the first of the $Al_2O_3:SiO_2$ ratios give the formula $CaAl_2Si_2O_8$; if lime be omitted, this becomes $Na_2Al_2Si_2O_8$. A careful study of the best analyses of thomsonite shows that alumina decreases as silica increases. Therefore it is reasonable to test the idea that in this zeolite, as in plagioclase, one atom of aluminum may take the place of one atom of silicon, or *vice versa*. In order to do so it is desirable to use molecules both more siliceous and less siliceous than the standard thomsonite formula already derived. To avoid too great differences the series may be written thus:

	Lime	Soda
More siliceous	$Ca_3Al_6Si_{10}O_{32}.Aq.$	$Na_6Al_6Si_{10}O_{32}.Aq.$
Standard	$Ca_4Al_8Si_8O_{32}.Aq.$	$Na_8Al_8Si_8O_{32}.Aq.$
Less siliceous	$Ca_5Al_{10}Si_6O_{32}.Aq.$	$Na_{10}Al_{10}Si_6O_{32}.Aq.$

By taking these more siliceous and less siliceous lime and soda molecules as the corners of a square, as in Fig. 1, various points in the square represent varying proportions of the four molecules which may be read directly from the diagram. For example, analysis 66 contains 26% of soda molecules (B and D) and 74% of lime molecules (A and C); it also contains 57% of the more siliceous molecules (A and B) and 43% of the less siliceous molecules (C and D); therefore it contains 74% of 57% or 42% of $Ca_3Al_6Si_{10}O_{32}$, 26% of 57% or 15% of $Na_6Al_6Si_{10}O_{32}$, 74% of 43% or 32% of $Ca_5Al_{10}Si_6O_{32}$, and 26% of 43% or 11% of $Na_{10}Al_{10}Si_6O_{32}$. It is evident that various points in the square represent varying ratios so far as $Al_2O_3:SiO_2$ and $CaO:Na_2O$ are concerned, but a constant unit ratio between Al_2O_3 and $CaO+Na_2O$.

In order to calculate from a chemical analysis the molecular percentage of the molecules of the square which are represented by the analysis (that is in order to find the point which represents the analysis on the square) it is, of course, necessary, first, to obtain the relative number of oxide molecules by dividing each weight percentage of the analysis by the molecular weight of the given oxide.[12] It is then possible to obtain the percentage of soda molecules by dividing the Na_2O (including K_2O) by the sum of CaO (including MgO, etc.) and Na_2O molecules. Finally, to obtain the percentage of the more siliceous molecules, let

$x = Al_2O_3$ molecules in the less siliceous molecules

$y = Al_2O_3$ molecules in the more siliceous molecules.

then $x+y =$ total number of Al_2O_3 molecules in the analysis, and

$6/5x + 10/3y =$ total number of SiO_2 molecules in the analysis.

After solving for x and y, it may be noted that there are $y/3$ of the more siliceous molecules (since each contains $3Al_2O_3$) and $x/5$ of the less siliceous molecules; therefore $y/3 \div y/3 + x/5 =$ percentage of more siliceous molecules.

Since the diagram is based on the assumption that the $Al_2O_3:CaO+Na_2O$ ratio is unity, it is desirable to use, first, only those analyses which do not depart appreciably[13] from this condition. In this way the numbered points on Fig. 1 are found, the numbers corresponding with the list already given. Analyses which do not give a unit ratio for Al_2O_3:$CaO+Na_2O$ cannot be calculated into the molecules of Fig. 1, without leaving discrepancies, whose magnitude varies with the departure from unit ratio. If these discrepancies are equally divided between Al_2O_3 and $CaO+Na_2O$ points can be found; if the discrepancies are attributed wholly to Al_2O_3 other points can be found; if they are attributed wholly to $CaO+Na_2O$ still other points can be found. A line connecting the second and third of these points for a given analysis is bisected by the first point named and represents all possible assumptions regarding elimination of the condition that the Al_2O_3:$CaO+Na_2O$

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[12] To reduce the labor involved the writer uses the molecular weight only to the nearest whole number; it is customary to multiply by 1000 to eliminate decimals.

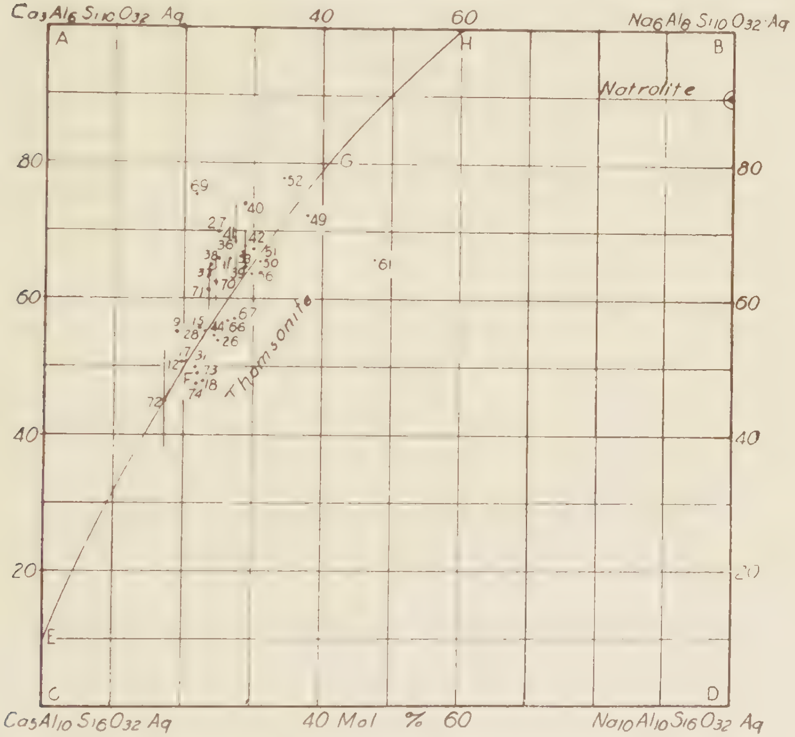

Fig. 1. The composition of thomsonite. Each dot represents an analysis.

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[13] Any small discrepancy is divided equally between Al_2O_3 and $CaO+Na_2O$ in the actual computations.

ratio is not unity. Such lines are vertical in Fig. 1 since the $CaO:Na_2O$ ratio is not affected by the various methods of eliminating the discrepancy.

By plotting all the "superior" analyses as points and some[14] of the other modern analyses as lines; as just described, the range of variations in composition can be seen very readily, as shown in Fig. 1. The diagram shows, not two species, but a continuous series between limits which are not clearly defined. Only two analyses (61 and 69) depart rather widely from the main series. It is reasonable to disregard these as due to impurities or inaccuracies (61 is rather old and 69 was made on massive rather than crystal material) and conclude that thomsonite varies in composition essentially as expressed by a line running about NE and SW in Fig. 1, such as EFGH (the reason for the curvature of this line will be given later).

The complete formula for the point F may be written $Na_4Ca_8Al_{20}Si_{20}O_{80}$ and the complete formula for the point H is, $Na_9Ca_3Al_{15}Si_{25}O_{80}$. These formulas are very complex, but the first one is (four times) the formula deduced by Wherry for one of his types. However, the striking and most important feature about them is that they contain exactly the same number of atoms, and the replacements are just the same as in plagioclase. In fact the series can be considered to parallel part of the plagioclase series, differing only in the fact that there are in thomsonite (about) 12 (Ca+Na) atoms for each 80 oxygen atoms, while in plagioclase there are only 10 (Ca+Na) atoms for each 80 oxygen atoms.

In Fig. 1 the four components of the system do not have the same (Ca+Na):O ratio, although this ratio is the same for the points F and G. Therefore a straight line from F to H would not express simple mixtures of F and H (which have the same ratio). Such mixtures are expressed by the curved line EFGH whose position can be found by plotting a few points along its course. It is evident that the points which represent the analyses all fall near this curve. It seems clear that the isomorphous series in thomsonite may be considered to be one in which Ca is replaced not by 2Na, nor 2Si by 3Si nor by 6Si, as has been suggested,[15] but that, as in plagioclase, Ca is replaced by Na with a simultaneous replacement of Al by Si.

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[14] It seems quite unnecessary to calculate all of these; enough of these and of good older analyses have been calculated to make sure that they would not alter the conclusions reached.

[15] S. G. Gordon: *Proc. Phila. Acad. Sci.*, **LXXVI,** (1924) p. 103, and C. F. Rammelsberg: Min. Chem. Erg. Heft **II,** (1895) p. 389.

Therefore, in thomsonite as in the anhydrous silicates, a natural isomorphous series is formed not between molecules which are unlike in number and size of atoms, but between molecules having exactly the same number of atoms of nearly the same sizes; the replacement is not 2Na for Ca and 3Si for 2Si, but, Na for Ca and Si for Al.

Accordingly, accepting the conclusions of Gordon regarding the water in thomsonite (with which this article does not deal) the mineral is an isomorphous series from about the point F whose composition is $Na_4Ca_8Al_{20}Si_{20}O_{80}{\cdot}25H_2O$ nearly to the point G whose composition is $Na_7Ca_5Al_{17}Si_{23}O_{80}{\cdot}20H_2O$.

(*To be continued*)

FOSHAGITE, A NEW SILICATE FROM CRESTMORE, CALIFORNIA[1]

Arthur S. Eakle, *University of California*

The Riverside Portland Cement Company which quarried the crystalline limestone at Crestmore, has transferred most of its operations to a hill, lying further west, of white crystalline limestone containing few associated minerals, and the original quarries have been practically deserted. The old Commercial quarry on Sky Blue Hill where the wilkeite and other minerals described by the writer[2] were found has been cleaned up and is not now of special interest. Some later quarrying has been done on the north side of the hill at what is locally known as the Wet Weather quarry, and there was a large accumulation of boulders at the base of this quarry last May, when visited by the writer. Brown and yellow vesuvianite and light blue calcite, principally, formed the boulders, but other minerals occur in the vesuvianite masses which make a visit to the deposit of great interest to the mineralogist. The solutions connected with the intrusive pegmatitic and monzonitic dikes in the limestone mass were magmatic siliceous waters which were in all probability responsible for the conversion of the limestone into the predominating masses of vesuvianite and garnet with recrystallized calcite. Minor amounts of sulphides accompanied the flows and the presence of these and of a phosphate in the original limestone may account for the unusual localized development of calcium derivatives of one-, two-, three-, and four-acid solutions. The possibilities of new mineral species formed by the action of such thermal solutions are so great, that it occasions slight wonder that each visit to the quarries results in the finding of one or more. One is fortunate to catch them before they disappear into cement.

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[1] Presented at the annual meeting of The Mineralogical Society of America, Ithaca, New York, December 31, 1924.

[2] Minerals associated with the crystalline limestone at Crestmore, Riverside County, California. Arthur S. Eakle. *Bull. Dept. Geol. Univ. Calif.*, **10**, 327-360 (1917).

Wide veins of a white, fibrous mineral were observed in one of the large vesuvianite boulders which the writer was confident had not been noted before and a good supply of specimens were collected, which was fortunate, as Mr. Foshag visited the quarry in September, having in mind to get some of the mineral and reported all the boulders had disappeared.

The mineral proves to be a new ortho-silicate and the name *foshagite* is proposed for it in honor of W. F. Foshag, who has added considerable to our knowledge of the minerals of these hills.

The mineral has a very compact fibrous structure with the fibers perfectly parallel and several inches long in some of the veins. It has a snow-white color and somewhat silky luster. In some portions of the boulder it appears intergrown with the vesuvianite but in general its contact with the vesuvianite is in sharply defined walls, with the fibers normal to these walls. Granular masses of very glassy thaumasite and large cleavage rhombohedrons of deep blue calcite are in close association with the foshagite.

The fibers are soft and brittle, but the compact mass has a hardness of 3. G. = 2.36, determined with the pycnometer. When the mineral is ignited to expel water it becomes a pale blue. Heated with the blowpipe it becomes incandescent and converted into a vitrified mass which is infusible. Easily soluble in HCl with abundant gelatinization.

Analyses of the mineral were made by C. A. Gentle of the College of Chemistry and also by the writer. Dr. Blasdale kindly made a determination of CO_2 which served as a check. The fibers effervesce so it was thought the mineral might be a carbonate-silicate which its intimate association with thaumasite could well indicate, but the small percentage of CO_2 present does not support such a belief.

The average of the several analyses gave as the composition of the mineral

	Percentages	Ratios	Approx. ratios
SiO_2	33.92	.562	3
Fe_2O_3	0.83		
CaO	53.48	.954	5
MgO	tr		
CO_2	1.83		
H_2O	10.19	.562	3
	100.25		

The combining ratio of SiO_2:CaO:H_2O suggested here is 3:5:3. This is not materially changed by deducting the $CaCO_3$ and calculating the composition as a pure hydrous calcium silicate and this gives:

SiO_2	35.62	.591	3
CaO	53.68	.957	5
H_2O	10.70	.593	3

The composition of foshagite is therefore $5CaO.3SiO_2.3H_2O$ and this can be expressed as an orthosilicate by the formula, $H_2Ca_5(SiO_4)_3.2H_2O$.

The optical determinations were carefully carried out by C. A. Anderson, Teaching Fellow in Mineralogy. The fibers show parallel extinction indicating orthorhombic crystallization. Elongation is positive, a characteristic of all these hydrous calcium silicates. Very low birefringence. Indices of refraction: $\alpha=\beta=1.594$; $\gamma=1.598$. Optically positive.

Foshagite approaches the mineral hillebrandite in its composition but is deficient in CaO in its relation to SiO_2 to conform to the simple ratio of 2:1:1 for CaO:SiO_2:H_2O as in that mineral. The indices of these fibrous silicates are very similar.

		α	β	γ
Crestmoreite	$H_8Ca_4(SiO_4)_4.3H_2O$	1.593	1.603	1.607
Riversideite	$H_4Ca_2(SiO_4)_2.H_2O$	1.595	1.60	1.603
Hillebrandite	$Ca_2(SiO_4).H_2O$	1.605	1.61	1.612
Foshagite	$H_2Ca_5(SiO_4)_3.2H_2O$	1.594	1.594	1.598

CAMSELLITE FROM CALIFORNIA[1]

ARTHUR S. EAKLE, *University of California*

In the construction of a new highway along the east shore of Bolinas Bay, near Stinson Beach, Marin County, California, the road cuts through a mass of highly sheared and shattered serpentine mixed with white veinlets of calcium and magnesium carbonates. Imbedded in this mass are many small boulders of typical dark green serpentine, and in one small area these boulders are coated and impregnated with a white deposit of a minutely fibrous mineral as soft as flour. The mineral was observed and collected by Mr. Vonsen and he determined it to be a hydrous borate of magnesium, but with silica present, and samples were brought to the writer for identification. The mineral was evidently a new borate for California and was thought possibly a new mineral species. Its composition and indices indicate that it is the same borate that Ellsworth and Poitevin[2] described from a similar association in British Columbia and named, camsellite.

The Canadian borate was described as occurring intimately admixed with chrysotile and dolomite, to the extent of over twenty-three percent, according to their analysis, since they credited all the silica to chrysotile. This left by deduction a simple hydrous magnesium borate with an indicated formula, $2MgO.B_2O_3.H_2O$.

The writer is fortunate in having an abundance of the pure mineral for analyses. Every fissure of the boulders has been filled with the mineral so when they are broken practically every specimen is coated. No dolomite or chrysotile occurs with it and by lightly scraping the coatings pure material was obtained. The mineral was also floated for some of the samples and four different samples were used for the analyses. Silica and ferrous iron were present in constant amounts. Calcium and manganese were absent. The average of the analyses gave the composition:

	Percentages	Ratios	
MgO	46.07	1.142	$=1.176=2$
FeO	2.46	.034	
B_2O_3	33.34	.476	$=.595=1$
SiO_2	7.16	.119	
H_2O	10.94	.607	$=.607=1$
	99.97		

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[1] Presented at the annual meeting of The Mineralogical Society of America, Ithaca, New York, December 31, 1924.

[2] H. V. Ellsworth and Eugene Poitevin: Camsellite, a new borate mineral from British Columbia, Canada. *Trans. Roy. Soc. Canada*, **15**, 1-8, (1921).

The formula indicated by the ratios is: 10 (MgO, FeO).$4B_2O_3$.SiO_2.$5H_2O$ but this is simplified to 2(MgO, FeO).(B_2O_3,SiO_2).H_2O by considering the SiO_2 as replacing B_2O_3. It is not a case of admixed silica or silicate, but rather a definite replacement of one molecule of B_2O_3, by SiO_2; otherwise the mineral is an isomorphous mixture of the borate and silicate of magnesium. The formula 4(2MgO.B_2O_3.H_2O).(Mg, Fe)$_2SiO_4$.H_2O will also fit the analysis, but the simpler formula seems preferable.

The formula 2MgO.B_2O_3.H_2O, given for camsellite requires 41.81% B_2O_3 and the analyses of the pure mineral show that only four-fifths of this amount is present, with silica representing the remaining fifth.

Ferrous iron is a constant constituent replacing some of the magnesia and is therefore included in the formula.

The theoretical composition of camsellite based on the formula: 2(MgO, FeO).(B_2O_3,SiO_2).H_2O with MgO:FeO = 34:1 and B_2O_3:SiO_2 = 4:1 becomes:

MgO	46.33
FeO	2.43
B_2O_3	33.46
SiO_2	7.13
H_2O	10.65
	100.00

The specific gravity determined with the pycnometer is 2.60.

The optical data were carefully determined by C. A. Anderson, Teaching Fellow in Mineralogy, and agreed closely with those already given for camsellite. The fibers show parallel extinction with negative elongation; $\alpha = 1.580$; $\gamma = 1.651$.

The solubility of the mineral tends to confirm the indicated fact that silica is a constituent of the fibers. We would expect a simple borate to be easily soluble in HCl but such is not the case with this camsellite. It is so slowly attacked that boiling for hours fails to decompose it, and this method of getting it into solution could not be used. However, after simple ignition it goes readily into solution with the separation of gritty silica. The silica may act like an opal in the fibers preventing them from ready attack by the acid and dehydration changes this condition of the silica.

Camsellite is the seventeenth borate found in the State and owes its origin probably to borated waters of a hot spring acting on the serpentine.

BARITE AND ASSOCIATED MINERALS IN CONCRETIONS IN THE GENESEE SHALE

J. H. C. Martens, *Cornell University*

Concretions in the Genesee shale near Cayuga and Seneca lakes in central New York contain barite and several other minerals, some of which do not seem to be generally known as occurring in this region. These concretions were briefly mentioned in the reports on the geology of the third and fourth districts of the State by Lardner Vanuxem[1] and James Hall,[2] respectively. The former seems to have mistaken the large white crystals of barite for celestite, but perhaps actually found celestite in place of barite at some locality.

The concretions described in this paper occur in the Genesee shale about 30 feet from the base of the formation. The extent of their geographic distribution has not been determined, but they were seen by the writer in gorges along Cayuga Lake at several localities between Portland Point on the east side, and Interlaken, nearly 15 miles to the northwest on the west side of the lake; also near Lodi on the east side of Seneca Lake. Concretions which may be similar to these are reported by Hall as occurring in this formation in the gorge of the Genesee River.

The concretions, which are composed of a hard, dark limestone, are lenticular in shape and flattened parallel to the bedding of the shale. More rarely they are nearly spherical. In horizontal section all are circular or elliptical. The smallest ones are about 30 cm. (1 foot) in diameter by 10 or 12 cm. (4 or 5 inches) thick, and the largest ones have at least twice these linear dimensions. The shale laminations bend around the concretions both above and below, and the joints in the shale cut across both the concretions and the veins which they contain.

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[1] Vanuxem, Lardner, Natural History of New York, Geology, part III, p. 169, **1842**.

[2] Hall, James, Natural History of New York, Geology, part IV, pp. 219, 221, **1843**.

In nearly all of these concretions there are cracks partly or completely filled with vein minerals, and in some these are abundant enough so the concretion might properly be called a septarium. The widest veins are vertical or nearly so and while horizontal cracks occur they seem to have been held shut so tightly that little material could be deposited in them. Many of the vertical veins are widest in the center and some do not continue to the outside at all.

The minerals in these veins are barite, calcite, ankerite, quartz, marcasite, and sphalerite, named in order of abundance. Galena is also mentioned by Hall as being rarely present. Each of these minerals will be briefly described as to its properties and mode of occurrence.

Calcite was the first mineral to be deposited and lines most of the vein walls. It was also formed to some extent after the barite and quartz but apparently none was deposited after the ankerite. The older calcite is colored brown to black by unevenly distributed bituminous material. Crystal faces are rarely observed because they are covered by other minerals. Some of the younger calcite is in cavities which are still partly open, and consists of crystals of a rather blunt dog-tooth spar habit.

Barite occurs in white to nearly transparent crystals flattened parallel to (001) and frequently having this form parallel to the wall of the vein. The larger ones are 8 or 10 cm. (3 or 4 inches) in width by 2 or 3 cm. (1 inch) thick. The barite rests upon the earlier calcite and fills the spaces between the crystals. It seldom has crystal faces because of interference of one crystal with another or with the vein wall. In some instances an entire cavity is filled by a single barite crystal.

Ankerite fills in most of the spaces remaining between the barite crystals and is present in large amounts. It is yellow in color, has curved cleavage faces, and where a crystal is in an open space it shows the saddle shaped distorted rhombohedron so common on dolomite. The presence of iron is shown by the limonite stains produced by weathering and by the refractive index $\omega = 1.704$, which corresponds to about 15% $FeCO_3$, assuming that there are as many atoms of calcium as of iron and magnesium together.

Quartz occurs sparingly in clear colorless crystals showing the usual forms $(10\bar{1}0)$, $(10\bar{1}1)$, and $(0\bar{1}11)$ with very narrow faces of steeper rhombohedrons. Where its relation to the other minerals could be determined it is younger than the barite but older than the ankerite and part of the calcite.

Marcasite is present in small amount in some of the concretions as crystals only a few tenths of a millimeter in diameter.

Sphalerite of yellow color occurs in crystals up to 4 or 5 mm. in diameter, associated with the dark colored calcite. It was deposited before the barite.

The order of formation of these minerals is then, so far as could be determined, calcite, sphalerite, barite, quartz, calcite, ankerite with the position of the marcasite not definitely known.

It would be of interest to investigate the areal distribution of these concretions and to attempt to explain their localization at this particular horizon, and account for the concentration of the minerals in them. Upon casual examination the part of the shale containing them does not differ in any other way from the rest of the formation.

BOOK REVIEWS

LEHRBUCH DER MINERALOGIE. I, ALLGEMEINE MINERALOGIE. PAUL NIGGLI. Large 8-vo., 712 pages, with 553 text figures. Gebrüder Borntraeger, *Berlin*, 1924.

This is a complete revision of the first edition of this text, published in 1920 (*Am. Min.*, **7**, 125, 1922), which departed markedly from the conventional and well-established method of presenting mineralogical data and material.

The reception of the first edition was apparently of such a favorable character as to warrant the author to materially expand the new edition. Accordingly, the second edition will appear in three parts as follows: I, GENERAL MINERALOGY; II, SPECIAL MINERALOGY; III. MINERAL ASSOCIATIONS, the author applies the term "Minerocoenology" to this part. Of the three parts, GENERAL MINERALOGY or Part I, has been issued. Part II, SPECIAL MINERALOGY, will appear in the near future.

Following a short introduction (4 pages), the matter contained in Part I, is devoted to geometrical crystallography (137 pages), physical properties of crystals (233 pages), chemical properties of crystals (201 pages), and amorphous minerals (18 pages). The same high quality so characteristic of the first edition is maintained throughout this part, which will rank as a very valuable contribution to our science.

EDWARD H. KRAUS.

CRYSTALS AND THE FINE-STRUCTURE OF MATTER. FRIEDRICH RINNE. Translated into English by WALTER S. STILES. 8-vo., 195 pages, with a drawing by A. Duerer, and portraits of the leading investigators in the study of fine-structure, and 203 figures. Methuen & Company, Ltd., *London*, 1924.

This English translation of Professor F. Rinne's excellent survey of our knowledge of crystal structure, published in German in 1922 under the title of DAS

FEINBAULICHE WESEN DER MATERIE NACH DEM VORBILDE DER KRISTALLE (*Am. Min.*, **8**, 13, 1923; also *Am. Min.*, **7**, 161, 1922) will be greatly welcomed by all interested in this important subject, especially by those who experience difficulty in reading German. The translation is very well done and the illustrations, notably the portraits, are much superior to those appearing in the original volume.

EDWARD H. KRAUS.

MIKROSKOPISCHE MINERALBESTIMMUNG MIT HILFE DER UNIVERSALDREHTISCHMETHODEN. M. BEREK. Large 8-vo., 168 pages, with 55 text figures, 5 tables, and 6 diagrams. Gebrüder Borntraeger, *Berlin*, 1924.

Methods for the determination of minerals by means of the Universal rotation-apparatus, which by experience have been found to be of practical value, are discussed in considerable detail. The text is designed for those who are fairly well grounded in optical mineralogy and microscopic technique.

EDWARD H. KRAUS.

PROCEEDINGS OF SOCIETIES

NEW YORK MINERALOGICAL CLUB

Regular Monthly Meeting of December 17, 1924

A regular monthly meeting of the New York Mineralogical Club was held in the East Assembly Room of the American Museum of Natural History on the evening of December 17, at 8:15 P.M. The President, Dr. George F. Kunz, presided and there was an attendance of forty-five members.

The committee on membership reported favorably on the following names submitted at the November meeting: Lewis W. Mac Naughton, 654 Bergen Ave., Jersey City, N. J.; and Dr. Paul F. Kerr, Department of Mineralogy, Columbia University. These gentlemen were unanimously elected to membership. The President submitted the name of Alfred E. Hammer, Branford, Conn., for life membership. The membership committee reported favorably upon Mr. Hammer's membership and he was elected unanimously.

The President then introduced the speaker of the evening, Dr. Charles Palache of Harvard University, who addressed the Club upon "*The Minerals of the Maine Pegmatites.*" Dr. Palache spoke of his early recollections of the Paris locality 30 years ago, mentioning among the names of the old local collectors that of Norris Merrill. He touched upon the history of Mount Mica, the most famous of the Maine localities for gem tourmaline, and mentioned the rose quartz and lilac lithia mica as being characteristic of the Maine pegmatite localities. He spoke of the discovery of gem apatite on the Pulsifer farm on Mount Apatite in 1905 as the result of a search for tourmaline, and also spoke of the Littlefield farm quarry from which many fine tourmaline and other minerals have come. In touching on the Norway locality the speaker recalled Mr. Noyes, the artist, a keen collector of crystals who found the ledge of tourmaline in this locality. This ledge was the Greenwood Mine that Dr. Palache bought and worked for Harvard University. The speaker exhibited some problematical pseudomorphs from this locality which Dr. Warren has described as "after topaz." He told of the working of the Greenwood ledge in 1923, which, although producing some interesting minerals such as amblygonite and pinkish apatite, turned out to be on the whole not a profitable venture. The quarry at Buckfield which was being worked as a feldspar quarry developed toward the end of that same summer (1923) one of the largest cavities ever found in Maine. This vug which was ten feet in length was lined with quartz and feldspar as well as some of the rare manganese phosphates such as eosphorite, fairfieldite, lithiophilite, etc., which were formerly found at Branchville, Conn. Solution, producing honey-comb structure, was also characteristic of the Buckfield locality.

Dr. Palache mentioned a visit to the chrysoberyl locality, 20 miles north of Buckfield, which he described as being on the slopes of Ragged Jack Mountain. He spoke of the pollucite quarry owned by Mr. Bonny. In reviewing all these occurrences he dwelt on the alteration and replacement characteristic of many of the pegmatite localities. Speaking of the gem cutting skill that has developed among the Maine farmers, Dr. Palache showed lantern slides of and explained the ingenious machines for cutting the local gems invented by Dudley and Merrill, and spoke at some length on this comparatively unknown phase of the production of Maine gem minerals.

A vote of thanks was tendered to the speaker for his interesting and valuable address. The meeting was adjourned at 9:25 p.m.

Herbert P. Whitlock, *Recording Secretary.*

PHILADELPHIA MINERALOGICAL SOCIETY

Academy of Natural Sciences of Philadelphia, February 12, 1925

A stated meeting of the Philadelphia Mineralogical Society was held on the above date, with the vice-president, Mr. Trudell, in the chair. Twenty-seven members and four visitors were present.

Mr. Robert Kleinschmidt was elected a junior member. The names of Dr. Harry Winsor and Mr. Samuel Perlstein were proposed for membership.

Dr. Horace R. Blank addressed the society on "*Radioactivity in Minerals.*" The general nature of radioactivity was first described. All minerals containing radium or thorium are radioactive. Such minerals also contain the disintegration products of these elements, such as radium, mesothorium, helium, and lead. Radioactive minerals may be detected by their photographic effects and by the ionization which they produce in the surrounding air. The latter effect was demonstrated by the speaker with the aid of an electroscope. The age of the radioactive minerals as determined from the uranium: lead ratio was then discussed. The uses of radium and mesothorium were reviewed, and the talk was concluded by a brief mention of the principal radium producing localities of the world.

A resolution was passed instructing the secretary to convey the sympathy of the society to Mr. Vaux, the president, who is now confined to his home by illness.

Mr. R. M. Lane, a visitor, entertained the society by his personal recollections of the emery mines at Chester, Mass., at the time they were in active operation.

Horace R. Blank, *Secretary*

NEW MINERALS: DOUBTFUL SPECIES

CLASS: SILICATES

Parsettensite

Johan Jakob: Vier Mangansilikate aus dem Val d'Err (Kt. Graubünden). (Four manganese Silicates from Val d'Err, Canton Graubünden). *Schweiz. Min. Pet. Mitt.*, **3**, 227 (1924).

Name: From the locality, *Parsettens* Alps, Val d'Err, Switzerland.

Chemical Properties: A hydrous silicate of manganese, $3MnO. 4SiO_2. 4H_2O$. Analysis: SiO_2 42.90, Al_2O_3 4.35, Fe_2O_3 0.35, MnO 34.45, MgO 2.70, CaO tr., Na_2O 0.20, K_2O 0.94, H_2O+ 9.66, H_2O- 3.15, HCl 0.02, CO_2 0.25, V_2O_5 0.32. Sum 99.27. Sample analyzed carried a micaceous substance and some manganese oxides. Soluble in HCl with separation of silica. Fuses with intumescence to a dark brown bead.

Physical and Optical Properties: Massive, somewhat micaceous. Color copper red. Luster somewhat metallic. Uniaxial, negative. $\omega=1.576$, $\epsilon=1.546$. Pleochroism c = greenish yellow, a = light yellow to colorless. Sp. Gr. 2.59.

Occurrence: Found in the manganese deposits of Val d'Err, Canton Graubünden, Switzerland.

Discussion: Probably related to the indefinite mineral ekmanite and considered by Jakob to be a member of the pyrosmalite group. The analysis, however, was made upon material admittedly impure without determining the amount and character of the contaminating minerals. Further analyses on pure material are necessary to definitely establish this mineral.

W. F. Foshag

CLASS: SILICATES

Errite

Johann Jakob: *Op. Cit.*, p. 230.

Name: From the locality Parsettens Alps, Val d'*Err*, Switzerland.

Chemical Properties: A hydrous silicate of manganese. Analysis: SiO_2 41.20, Al_2O_3 4.44, Fe_2O_3 0.12, MnO 35.83, MgO 2.05, CaO 1.20, Na_2O 0.14, K_2O 1.23, H_2O+ 8.25, H_2O- 4.65, P_2O_5 0.56. Sum 99.67.

Physical and Optical Properties: Like parsettensite except the color is darker brown. Uniaxial negative. $\omega=1.575$, $\epsilon=1.547$. Pleochroism c = greenish yellow, a = light yellow to colorless.

Occurrence: In the manganese deposits of Val d'Err, Switzerland.

Discussion: This mineral differs in no essential particular from the parsettensite and undoubtedly represents the same species. The separation from parsettensite is based upon a slight difference in the water content. The sample analyzed was obviously impure.

W. F. F.

CLASS: SILICATES

Tinzenite

JOHANN JAKOB: *Op. Cit.*

NAME: From the locality, *Tinzen*, Val d'Err, Switzerland.

CHEMICAL PROPERTIES: A silicate of lime, alumina and manganese, $2CaO.Al_2O_3.Mn_2O_3.4SiO_2$. Analysis: SiO_2 42.55, Al_2O_3 18.83, Fe_2O_3 2.25, Mn_2O_3 20.65, MgO 0.07, CaO 13.82, Na_2O 0.71, K_2O 0.43, H_2O 1.25. Sum 100.56. Another analysis is also given.

PHYSICAL AND OPTICAL PROPERTIES: Color yellow, structure columnar. Cleavage pinacoidal, good. Biaxial, negative. $2V=62°$, $2E=124°30'$. $\alpha=1.693$, $\beta=1.701$, $\gamma=1.704$. Sp. Gr. 3.29.

OCCURRENCE: Found as a vein filling with quartz in the manganese mines of Val d'Err, Switzerland.

DISCUSSION: Jakob does not include in his formula the water content which may be essential to the mineral. A recalculation of his analysis shows a somewhat closer agreement with the formula $2CaO.\ 3(Al, Mn)_2O_3.\ 6SiO_2$ than the one given. The purity of the sample was not stated. The exact character of this mineral must be considered doubtful. W. F. F.

CLASS: SILICATES

Traversoite

A. D'Ambrosio: Sulla Traversoite, nuova varieta di Crisicolla di Arenas in Sardegna. (Traversoite, a new variety of chrysocolla from Arenas, Sardinia). *Annal. Museo Civico Storia Naturale di Genova.*, **51**, 5, (1924).

NAME: In honor of G. B. *Traverso*, mining engineer of Genoa, Italy.

CHEMICAL PROPERTIES: A hydrous silicate of copper and alumina, $2(Cu, Ca)O.Al_2O_3.2SiO_2.12H_2O$. Analysis H_2O 32.84, SiO_2 21.04, Al_2O_3 21.84, CuO 21.72, CaO 2.28. Sum 99.72.

PHYSICAL PROPERTIES: Amorphous. Color light blue. Compact, porcelain like.

OCCURRENCE: Found at Arenas, Sardinia, upon a gangue of quartz, fluorite and barite, associated with azurite, malachite, chrysocolla, spangolite, connellite anglesite, leadhillite, cerussite, massicotite, linarite and caledonite.

DISCUSSION: A specimen that has come to the U.S. National Museum is isotropic with an index of refraction of 1.565 ± .005. A small amount of crystalline material is intermixed with the mineral. In composition it is similar to pilarite, which, however, is lower in water and alumina. Considering the apparent colloidal origin of the material considerable variation can be expected in a mineral of this character.

W. F. F.